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(54) Title: HEAT TRANSFER DEVICE

(57) Abstract

A heat transfer device comprising a refrigeration circuit containing a refrigerant and a refrigerant recovery system is described. The refrigerant recovery system comprises (A) a holding vessel for containing the refrigerant once the device has reached the end of its operational life and (B) refrigerant transfer means for transferring the refrigerant from the refrigeration circuit to the holding vessel. A method for recovering a refrigerant contained in a refrigeration circuit of a heat transfer device is also described. The method comprises the step of transferring at least a proportion of the total refrigerant charge to a holding vessel fixed to the heat transfer device by means of a refrigerant transfer pipe.

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HEAT TRANSFER DEVICE

The present invention relates to a heat transfer device, such as a refrigeration, air-conditioning or heat pump system and more particularly to a heat transfer device equipped with a refrigerant recovery system for collecting and storing the refrigerant circulating in the device once the device has come to the end of its operational life. The refrigerant is conveniently stored in a holding vessel which can be detached from the heat transfer device and transported to another site, e.g. for reclamation or destruction.

Heat transfer devices of the mechanical compression type such as refrigerators, freezers, heat pumps and air conditioning systems are well known. In such devices a refrigerant liquid of a suitable boiling point evaporates at low pressure taking heat from a surrounding heat transfer fluid. The refrigerant vapour generated in the evaporator passes to a compressor where it is compressed and from the compressor the vapour passes to a condenser where it condenses and gives off heat to another heat transfer fluid. The condensate is then returned through an expansion valve to the evaporator so completing the cycle. The mechanical energy required for compressing the vapour and pumping the liquid may be provided by an electric motor or an internal combustion engine.

Hitherto, heat transfer devices have tended to use fully and partially halogenated chlorofluorocarbon refrigerants such as trichlorofluoromethane (refrigerant R-11), dichlorodifluoromethane (refrigerant R-12) and chlorodifluoromethane (refrigerant R-22).

However, the fully halogenated chlorofluorocarbons have in particular been implicated in the destruction of the earth's protective ozone layer and as a result the use and production thereof has been limited by international agreement.

Replacements for some of the chlorofluorocarbon refrigerants presently in use have already been developed. These replacement refrigerants tend to comprise selected hydrofluorocarbons, i.e. compounds which contain only carbon, hydrogen and fluorine atoms in their structure. Thus, refrigerant R-12 is generally being replaced by 1,1,1,2-tetrafluoroethane (R-134a).

Hitherto, the refrigerants contained in defunct heat transfer devices have been discarded together with the device and as result tend to leak out into the atmosphere over time.

Despite the fact that the replacement refrigerants based on selected hydrofluorocarbons are ozone benign, it would still be prudent to recover the refrigerant from a defunct heat transfer system for subsequent destruction or reclamation rather than simply allow the refrigerant to escape into the atmosphere over time as part of the natural deterioration of the discarded system.

The present applicant has now devised a modified heat transfer device which comprises means for collecting and storing the refrigerant circulating in the device once the device has come to the end of its operational life. The refrigerant is conveniently stored in a holding vessel which can be detached from the heat transfer device and transported to another site, e.g. for reclamation or destruction.

According to one aspect of the present invention there is provided a heat transfer device comprising a refrigeration circuit containing a refrigerant and a refrigerant recovery system comprising:

(A) a holding vessel for containing the refrigerant once the device has reached the end of its operational life; and

(B) refrigerant transfer means for transferring the refrigerant from the refrigeration circuit to the holding vessel once the device has reached the end of its operational life.

Other than the refrigerant recovery system, the heat transfer device of the invention is typically of conventional construction. Typically the heat transfer device will comprise an evaporator, a compressor, a condenser and an expansion device such as an expansion valve or capillary tube which are connected together, e.g. by an arrangement of conduits.

The refrigerant recovery system of the present heat transfer device does not require a vacuum pump or auxiliary power.

In one embodiment the refrigerant transfer means comprises:

(B1) a refrigerant transfer pipe located between the refrigeration circuit and the holding vessel and connected thereto;

(B2) first sealing means which prevents refrigerant contained in the refrigeration circuit entering the refrigerant transfer pipe during the operational life of the device; and

(B3) means for opening the first sealing means at the end of the

operational life of the device so as to allow refrigerant contained in the refrigeration circuit to enter the refrigerant transfer pipe for transfer to the holding vessel.

The first sealing means may be part of the connection between the refrigeration circuit and the refrigerant transfer pipe. Preferably the refrigerant transfer pipe is attached to an outer wall section of the refrigeration circuit so that the first sealing means is constituted by the intact outer wall section to which the refrigerant transfer pipe is attached. The means for opening the first sealing means in this preferred embodiment may comprise a hollow puncture needle which is operable to puncture the outer wall section of the refrigeration circuit to which the refrigerant transfer pipe is attached so that the refrigerant can then enter the refrigerant transfer pipe. Conveniently, the refrigerant transfer pipe is attached to the compressor casing.

In this embodiment, the holding vessel or some other part of the refrigerant recovery system is preferably provided with second sealing means, e.g. a valve or arrangement of valves, which is operable when the refrigerant has been transferred to the holding vessel to prevent the escape of refrigerant contained in that vessel. The second sealing means should also enable the holding vessel to be detached from the heat transfer device without the escape of the refrigerant it contains. In a preferred embodiment, the operation of the second sealing means is automatic.

The refrigerant recovery system may also be provided with third sealing means located in the connection between the holding vessel and the refrigerant transfer pipe and means for opening the third sealing means at

the end of the operational life of the device so as to allow refrigerant entering the refrigerant transfer pipe to pass into the holding vessel. Preferably the refrigerant transfer pipe is attached to an outer wall section of the holding vessel so that the third sealing means is constituted by the intact outer wall section to which the refrigerant transfer pipe is attached. The means for opening the third sealing means may comprise a hollow puncture needle which is operable to puncture the outer wall section of the holding vessel to which the refrigerant transfer pipe is attached so that the refrigerant can then enter the holding vessel.

In another embodiment the refrigerant transfer means comprises:

(B1) a refrigerant transfer pipe locatable between the refrigeration circuit and the holding vessel and connectable thereto;

(B2) first coupling means comprising a first connector attached to one end of the refrigerant transfer pipe and a complementary second connector attached to an outer wall portion of the refrigeration circuit, the first and second connectors being adapted to sealingly engage and to puncture the outer wall portion of the refrigeration circuit to which the second connector is attached when they are brought into sealing engagement; and

(B3) second coupling means comprising a third connector attached to the other end of the refrigerant transfer pipe and a complementary fourth connector attached to an outer wall portion of the holding vessel, the third and fourth connectors being adapted to sealingly engage and to puncture the outer wall portion of the holding vessel to which the fourth connector is attached when they are brought into sealing engagement.

In this embodiment, the holding vessel or some other part of the refrigerant recovery system is preferably provided with sealing means, e.g. a valve or arrangement of valves, which is operable when the refrigerant has been transferred to the holding vessel to prevent the escape of refrigerant from that vessel. Conveniently, this sealing means is only operable once the transfer tube is sealingly engaged to both the refrigeration circuit and the holding vessel. Moreover, the sealing means should also enable the holding vessel to be detached from the heat transfer device without the escape of the refrigerant it contains. In a preferred embodiment, the operation of this sealing means is automatic.

The refrigerant transfer pipe may be fixed to a part of the heat transfer device, e.g. by means of a bracket, and then removed from this fixing at the time of use for connection between the refrigeration circuit and the holding vessel. Alternatively, the refrigerant transfer pipe may be brought to the site of the heat transfer device by the service engineer who is recovering the refrigerant.

The connection between the first and second connectors and the third and fourth connectors may be by complementary threaded portions.

According to a second aspect of the present invention there is provided a method for recovering a refrigerant contained in a refrigeration circuit of a heat transfer device which method comprises the step of transferring at least a proportion and preferably a substantial proportion, e.g. at least 80 weight %, preferably at least 85 weight % and more preferably at least 90 weight % of the total refrigerant charge, to a holding vessel fixed to the heat transfer device by means of a refrigerant transfer pipe.

The refrigerant transfer pipe may already be connected to both the refrigeration circuit and the holding vessel, in which case transfer of the refrigerant will involve opening or breaking a seal which in normal operation of the heat transfer device prevents the refrigerant contained in the refrigeration circuit from leaking into the refrigerant transfer pipe. If a further seal is located in the connection between the holding vessel and the refrigerant transfer pipe, then it will also be necessary to open or break this seal.

If the refrigerant transfer pipe is not already connected to both the refrigeration circuit and the holding vessel, then the method of the invention will comprise connecting the refrigerant transfer pipe to the holding vessel and to the refrigeration circuit, preferably in that order, by means of complementary connectors provided on an outer wall portion of both the refrigeration circuit and holding vessel and on either end of the transfer pipe. These connectors are preferably adapted to sealingly engage and to puncture the refrigeration circuit and the holding vessel when they are brought into sealing engagement. However, other means of opening the seals may also be provided.

Once the refrigerant has been transferred, the holding vessel should be sealed and then detached from the heat transfer device.

The refrigerant contained in a refrigeration circuit will ordinarily be under pressure and this pressure may well be sufficient to drive the refrigerant from the refrigeration circuit through the refrigerant transfer pipe and into the holding vessel. However, in a preferred embodiment the holding

vessel is evacuated so as to assist with the transfer of the refrigerant from the refrigeration circuit to the holding vessel. Transfer of the refrigerant may also be facilitated by cooling the holding vessel, e.g. with ice.

The removal of the refrigerant and optionally the lubricant from the refrigeration circuit may also be assisted by purging the refrigeration circuit with an another gas such as air.

The holding vessel may be a discrete vessel which has been incorporated in the heat transfer device for the sole purpose of containing the refrigerant once the device has reached the end of its operational life. In this embodiment, the holding vessel may take the form of a canister or cartridge which contains an adsorbent for the refrigerant. Suitable adsorbents, depending on the nature of the refrigerant to be adsorbed, may include activated carbon, charcoal, high surface area polar organic polymer foams, e.g. polyurethanes and acrylics, aerogels, zeolites (aluminosilicates), silica and alumina. Other suitable adsorbents include porous solids, e.g. porous inorganic solids, which have been impregnated with a good solvent for the refrigerant such as acetone in the case of 1,1,1,2-tetrafluoroethane (R-134a). A preferred adsorbent, particularly for refrigerants based on one or more hydrofluorocarbons is activated carbon on account of its high affinity for hydrofluorocarbons, its high chemical stability allowing for re-use of the material, its high surface area per unit weight and its low density.

However, if the heat transfer device comprises hollow insulation panels, as is the case with refrigerators and freezers where the panels are assembled to provide an insulated cold store or cabinet, one of the hollow

panels preferably serves as the holding vessel once the heat transfer device has come to the end of its operational life. The insulation panel is preferably evacuated in order to facilitate the transfer of refrigerant from the refrigeration circuit, and in a preferred embodiment the door panel provides this secondary function, since it can be conveniently detached from the heat transfer device and then transported to another site for destruction or reclamation of the refrigerant.

Conveniently the insulation panel is filled with an open cell polymer foam, such as an open cell polyurethane foam, which may act to absorb the refrigerant which will not only tend to reduce the pressure generated by the refrigerant gas, but may also help to purge the refrigeration circuit of the refrigerant it contains. The absorbing power of the polymer foam may be augmented by impregnating the foam with a finely divided adsorbent for the refrigerant such as activated carbon. The adsorbent might be blended with the foam formulation prior to injection into the panel where it might also provide nuclei to initiate foaming. Alternatively, the adsorbent might be contained in a discrete section of the panel and kept in fluid communication with the polymer foam by means of apertures or ducts.

In a preferred embodiment, a substantial proportion, e.g. at least 50 % by weight and preferably at least 80 % by weight, of the lubricant contained in the refrigeration circuit will also be transferred to the holding vessel along with the refrigerant. The simultaneous transfer of the lubricant may help to reduce the vapour pressure of the refrigerant and at the same time may allow a significant proportion of the refrigerant, which is likely to be a gas at ambient temperatures and pressures, to be removed in liquid form

as a solution in the lubricant. Furthermore, recovery of the lubricant along with the refrigerant may allow the lubricant to be reclaimed as well as the refrigerant, or if the refrigerant is to be disposed of by incineration then the lubricant will provide a source of fuel.

The removal of both the refrigerant and lubricant may be assisted by injecting a solvent for the refrigerant and lubricant such as acetone into the refrigeration circuit. This will tend to increase the solubility of the refrigerant in the liquid phase and reduce the viscosity of the lubricant. The solvent can then be removed along with the refrigerant and lubricant.

If the pressure in the holding vessel following transfer of the refrigerant is super atmospheric, then the walls of the holding vessel will need to be sufficiently strong to withstand this stress. However, where an evacuated holding vessel is employed, such as an evacuated insulation panel, the refrigerant recovery system should be designed so that the pressure in the holding vessel following transfer is sub-atmospheric. This can be achieved by employing an evacuated holding vessel having a volume which is sufficiently large in relation to the refrigerant charge to obtain a sub-atmospheric condition following transfer. In addition, the materials which are typically used to fill vacuum panels may also act as an adsorbent for the refrigerant which will also help to reduce the refrigerant vapour pressure. Examples of these materials include the open cell polyurethane foams discussed above and fine silica fillings used to strengthen the panels, adsorbents such as activated carbon and zeolites which are used to remove residual gases, IR blocking agents such as carbon black, Fe_2O_3, mica, talc, Al_2O_3 and TiO_2, and nucleating agents such as mica and talc particles.

Once the refrigerant has been transferred from the refrigeration circuit to the holding vessel, the holding vessel can be sealed to prevent the escape of refrigerant and detached from the heat transfer device for treatment at another site. This may be achieved by simultaneously cutting and crimping the refrigerant transfer pipe so that the pipe is sealed as it is cut in order to prevent refrigerant loss. However, in a preferred embodiment the holding vessel or some other part of the refrigerant recovery system is provided with sealing means as described above which is operable when the refrigerant has been transferred to the holding vessel to prevent the escape of refrigerant from that vessel.

Treatment of the refrigerant may comprise destruction by incineration or purification by distillation. In the latter case the purified refrigerant can be reused.

The present invention is applicable to any refrigerant and particularly any organic refrigerant including the hydrocarbons, hydrochlorofluorocarbons, hydrofluorocarbons and perfluorocarbons. The refrigerant may also consist of a single refrigerant compound or a blend of such compounds and may be at sub-critical or super-critical conditions. In a preferred embodiment, the refrigerant comprises one or more hydrofluorocarbons and/or perfluorocarbons, particularly one or more hydrofluoroalkanes and more particularly one or more hydrofluoroalkanes selected from the hydrofluoromethanes and ethanes.

Suitable refrigerants for the heat transfer device of the present invention include chlorodifluoromethane (R-22), the azeotropic mixture of R-22 and

chloropentafluoroethane (R-115), the azeotrope being R-502, difluoromethane (R-32), 1,1-difluoroethane (R-152a), 1,1,1-trifluoroethane (R-143a), 1,1,2,2-tetrafluoroethane (R-134), 1,1,1,2-tetrafluoroethane (R-134a), pentafluoroethane (R-125), trifluoromethane (R-23), perfluoroethane (R-116), the azeotropic mixture of R-23 and R-116, the azeotrope being R-508 and perfluoropropane (R-218).

In a preferred embodiment, the refrigerant comprises one or more hydrofluoroalkanes selected from the group consisting of difluoromethane (R-32), 1,1-difluoroethane (R-152a), 1,1,1-trifluoroethane (R-143a), 1,1,2,2-tetrafluoroethane (R-134), 1,1,1,2-tetrafluoroethane (R-134a) and pentafluoroethane (R-125). Refrigerants which consist solely of or comprise R-134a are most preferred.

The present invention is now illustrated but not limited with reference to the following examples.

Example 1

A cabinet type freezer equipped with a compressor unit containing 150g of R-134a is fitted with a door insulated by a vacuum panel (1.47m x 0.58m x 0.04m) having an internal free volume of 34.1 litres. The volume of the refrigeration circuit is 3.25 litres. The door and the refrigeration circuit are linked by a connecting tube so that only R-134a vapour passes through the connecting tube. At 25°C the mass of R-134a transferred to the vacuum panel is 129.1 g and the R-134a pressure in the system is 0.86 bar.

Example 2

A cabinet type freezer equipped with a compressor unit containing 150g of R-134a is fitted with a door insulated by a vacuum panel (1.47m x 0.58m x 0.04m) having an internal free volume of 34.1 litres. The volume of the refrigeration circuit is 3.25 litres. The door and the refrigeration circuit are linked by a connecting tube so that the lubricant containing dissolved R-134a and then R-134a vapour can pass through the connecting tube. At 25°C the total mass of R-134a transferred to the vacuum panel is 145.5 g, i.e. 97%. The R-134a pressure in the system is 0.86 bar.

Example 3

A cabinet type freezer equipped with a compressor unit containing 150g of R-134a is fitted with a door insulated by a vacuum panel (1.47m x 0.58m x 0.04m) having an internal free volume of 34.1 litres. The volume of the refrigeration circuit is 3.25 litres. The door and the refrigeration circuit are linked by a connecting tube so that only R-134a vapour passes through the connecting tube. To increase the quantity of R-134a transferred to the vacuum panel while leaving the lubricant in the compressor sump, 200g of activated charcoal is incorporated into the panel filling so that it is accessible to the R-134a vapour. The mass of R-134a transferred to the vacuum panel is 140g, i.e. 93%. The R-134a pressure in the system is 0.4 bar.

Claims:

1. A heat transfer device comprising a refrigeration circuit containing a refrigerant and a refrigerant recovery system comprising:

(A) a holding vessel for containing the refrigerant once the device has reached the end of its operational life; and

(B) refrigerant transfer means for transferring the refrigerant from the refrigeration circuit to the holding vessel once the device has reached the end of its operational life.

2. A heat transfer device as claimed in claim 1, wherein the refrigerant transfer means comprises:

(B1) a refrigerant transfer pipe located between the refrigeration circuit and the holding vessel and connected thereto;

(B2) first sealing means which prevents refrigerant contained in the refrigeration circuit entering the refrigerant transfer pipe during the operational life of the device; and

(B3) means for opening the first sealing means at the end of the operational life of the device so as to allow refrigerant contained in the refrigeration circuit to enter the refrigerant transfer pipe for transfer to the holding vessel.

3. A heat transfer device as claimed in claim 2, wherein the refrigerant transfer pipe is attached to an outer wall section of the refrigeration circuit and the first sealing means is constituted by the intact outer wall section of the refrigeration circuit to which the refrigerant transfer pipe is attached.

4. A heat transfer device as claimed in claim 3, wherein the means for opening the first sealing means comprises a hollow puncture needle which is operable to puncture the outer wall section of the refrigeration circuit to which the refrigerant transfer pipe is attached.

5. A heat transfer device as claimed in any one of claims 2 to 4, wherein the refrigerant recovery system is provided with second sealing means which is operable when the refrigerant has been transferred to the holding vessel to prevent the escape of refrigerant contained in that vessel.

6. A heat transfer device as claimed in claim 5, wherein the second sealing means is also operable to enable the holding vessel to be detached from the heat transfer device without the escape of the refrigerant it contains.

7. A heat transfer device as claimed in any one of claims 2 to 6, wherein the refrigerant recovery system further comprises:

third sealing means located in the connection between the holding vessel and the refrigerant transfer pipe; and

means for opening the third sealing means at the end of the operational life of the device so as to allow refrigerant entering the refrigerant transfer pipe to pass into the holding vessel.

8. A heat transfer device as claimed in claim 7, wherein the refrigerant transfer pipe is attached to an outer wall section of the holding vessel and the third sealing means is constituted by the intact outer wall section of the holding vessel to which the refrigerant transfer pipe is attached.

9. A heat transfer device as claimed in claim 8, wherein the means for opening the third sealing means comprises a hollow puncture needle which is operable to puncture the outer wall section of the holding vessel to which the refrigerant transfer pipe is attached.

10. A heat transfer device as claimed in claim 1, wherein the refrigerant transfer means comprises:

(B1) a refrigerant transfer pipe locatable between the refrigeration circuit and the holding vessel and connectable thereto;

(B2) first coupling means comprising a first connector attached to one end of the refrigerant transfer pipe and a complementary second connector attached to an outer wall portion of the refrigeration circuit, the first and second connectors being adapted to sealingly engage and to puncture the outer wall portion of the refrigeration circuit to which the second connector is attached when they are brought into sealing engagement; and

(B3) second coupling means comprising a third connector attached to the other end of the refrigerant transfer pipe and a complementary fourth connector attached to an outer wall portion of the holding vessel, the third and fourth connectors being adapted to sealingly engage and to puncture the outer wall portion of the holding vessel to which the fourth connector is attached when they are brought into sealing engagement.

11. A heat transfer device as claimed in claim 10, wherein the refrigerant recovery system is provided with sealing means which is

operable when the refrigerant has been transferred to the holding vessel to prevent the escape of refrigerant from that vessel.

12. A heat transfer device as claimed in claim 11, wherein the sealing means is also operable to enable the holding vessel to be detached from the heat transfer device without the escape of the refrigerant it contains.

13. A heat transfer device as claimed in any one of the preceding claims, wherein the holding vessel is evacuated.

14. A heat transfer device as claimed in any one of the preceding claims, wherein the holding vessel comprises an adsorbent for the refrigerant contained in the refrigeration circuit.

15. A heat transfer device as claimed in claim 14, wherein the adsorbent is activated carbon.

16. A heat transfer device as claimed in any one of the preceding claims, wherein the holding vessel is constituted by an insulation panel which forms part of an insulated cold store or cabinet.

17. A heat transfer device as in claimed claim 16, wherein the insulation panel which functions as the holding vessel is the door panel.

18. A heat transfer device as claimed in claim 16 or claim 17, wherein the insulation panel is filled with an open cell polymer foam.

19. A heat transfer device as claimed in any one of the preceding claims, wherein the refrigerant comprises a hydrofluoroalkane.

20. A heat transfer device as claimed in claim 19, wherein the refrigerant comprises one or more hydrofluoroalkanes selected from the group consisting of difluoromethane (R-32), 1,1-difluoroethane (R-152a), 1,1,1-trifluoroethane (R-143a), 1,1,2,2-tetrafluoroethane (R-134), 1,1,1,2-tetrafluoroethane (R-134a) and pentafluoroethane (R-125).

21. A heat transfer device as claimed in claim 19, wherein the refrigerant comprises 1,1,1,2-tetrafluoroethane (R-134a).

22. A method for recovering a refrigerant contained in a refrigeration circuit of a heat transfer device which method comprises the step of transferring at least a proportion of the total refrigerant charge to a holding vessel fixed to the heat transfer device by means of a refrigerant transfer pipe.

23. A method as claimed in claim 22, wherein the removal of the refrigerant from the refrigeration circuit is assisted by purging the refrigeration circuit with air.

24. A method as claimed in claim 22 or claim 23, wherein a substantial proportion of the lubricant contained in the refrigeration circuit is also transferred to the holding vessel along with the refrigerant.

25. A method as claimed in claim 24, wherein the removal of the refrigerant and lubricant is assisted by injecting a solvent for the refrigerant and lubricant into the refrigeration circuit.

26. A method as claimed in any one of claims 22 to 24, wherein the refrigerant comprises a hydrofluoroalkane.

27. A method as claimed in claim 26, wherein the refrigerant comprises one or more hydrofluoroalkanes selected from the group consisting of difluoromethane (R-32), 1,1-difluoroethane (R-152a), 1,1,1-trifluoroethane (R-143a), 1,1,2,2-tetrafluoroethane (R-134), 1,1,1,2-tetrafluoroethane (R-134a) and pentafluoroethane (R-125).

28. A method as claimed in claim 26, wherein the refrigerant comprises 1,1,1,2-tetrafluoroethane (R-134a).

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 99/03616

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F25B45/00 B09B3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F25B B09B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	US 5 025 633 A (FURMANEK DANIEL J) 25 June 1991 (1991-06-25) the whole document	1-4,13, 19-22 5-12, 14-17 18,23
X Y	US 5 293 756 A (NELSON JOHN A ET AL) 15 March 1994 (1994-03-15) figures 2,5,7,20 column 6, line 60 - line 67 column 8, line 28 - line 32	22 5-9, 14-17, 24-28
Y	US 4 480 446 A (MARGULEFSKY ALLEN L ET AL) 6 November 1984 (1984-11-06) column 4, line 10 - line 16 figure 2	10-12

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
12 January 2000	19/01/2000
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer De Graaf, J.D.

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